



RV *Investigator* CTD Data Processing Report

Voyage ID	IN2024_V05
Voyage Title	SEA-MES: Untangling the causes of change over 25 years in the southeast marine ecosystem - Voyage 3
Depart	Hobart, 12 November 2024, 22:30 UTC
Return	Hobart, 12 December 2024, 22:30 UTC
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Document History

Date	Version	Author	Comments
28 March 2025	1.0	Mark Brunton	Initial version
10 June 2025	1.1	Mark Brunton	Reprocessed with updated version of CapPro

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1 Summary

Southeast Australia's marine waters are a global hotspot, experiencing rapid warming due to the expanding East Australian Current, which is four times the global average. Species are shifting southward, and extreme events like marine heatwaves are adding further impacts. These changes are expected to continue. The Australian Commonwealth Southeast Marine Park Network (SE-MPN), established in 2012, aims to protect the region's marine biodiversity, but it's unclear how ecosystem changes are affecting the parks. In 2015, experts recommended adaptive management strategies, including research and monitoring frameworks for better decision-making. The region is also home to vital fisheries, such as the Southern and Eastern Scalefish and Shark Fishery (SESSF), which have seen declines in key species and shifts in fish composition. The Southeast Australian Marine Ecosystem Survey (SEA-MES) voyage three, aims to document changes and establish a baseline to address questions about species changes, marine park management, and the implications for marine planning. The survey will also test new techniques for monitoring seabirds using an AI camera system.

The previous ecosystem survey took place 25 years ago, and this project aims to repeat it to document changes and establish a new biological and environmental baseline. The study will explore three key questions:

1. What factors have caused changes in fish populations and species abundance in the southeast ecosystem, and can these causes be addressed?
2. How do these changes influence the management of the region, particularly in terms of conservation and biodiversity within Australian Marine Parks, as well as the activities of fisheries, oil & gas, and renewable energy industries?
3. What are the implications of these changes for marine spatial planning and adaptive management in these sectors?

Significant aspects of this voyage from the perspective of the Data Acquisition and Processing (DAP) team include:

- 94 CTD deployments
- Issues with CTD winch heave compensation observed

This report describes the production of quality controlled, calibrated CTD data from RV *Investigator* voyage IN2024_V05.

Data for 94 CTD deployments were acquired using the Sea-Bird SBE911 CTD unit #24 (Serial Number 1332), fitted with 36 twelve-litre bottles on the rosette sampler. Sea-Bird-supplied calibration factors were used to compute the pressures and preliminary conductivity values. CSIRO-supplied calibrations were applied to the temperature data. The data were subjected to automated QC to remove spikes and out-of-range values.

Calibration for Active Heave Compensation (AHC) appears to have changed post dry dock, resulting in loops on SeaSave plots after AHC is turned on. This also caused the CTD wire to become slack due to the compensation sending out too much wire. Rapp McGregor assisted the Chief Engineer to dial down the maximum winch speed to prevent wire slack from occurring on up

heave, in the event the winch compensation was in phase with the actual heave. The issue was observed to cause an additive effect instead of the intended effect of keeping the CTD steady. The issue was further investigated and resolved following the voyage.

The final conductivity calibration was based on a single deployment grouping. The final calibration from the primary sensor had a standard deviation (SD) of 0.0015089 PSU, well within our target of 'better than 0.002 PSU'. The standard product of 1-decibar binned averages were produced using data from the primary sensors.

The dissolved oxygen data calibration fit had a SD of 0.83742 μM . The agreement between the CTD and bottle data was good.

Fluorometer, transmissometer, PAR, CDOM and turbidity sensors were also installed on the auxiliary A/D channels of the CTD.

To access the full voyage plan and other reports and data associated with this voyage, please see the contact information at the end of this report.

1.1 Voyage Track

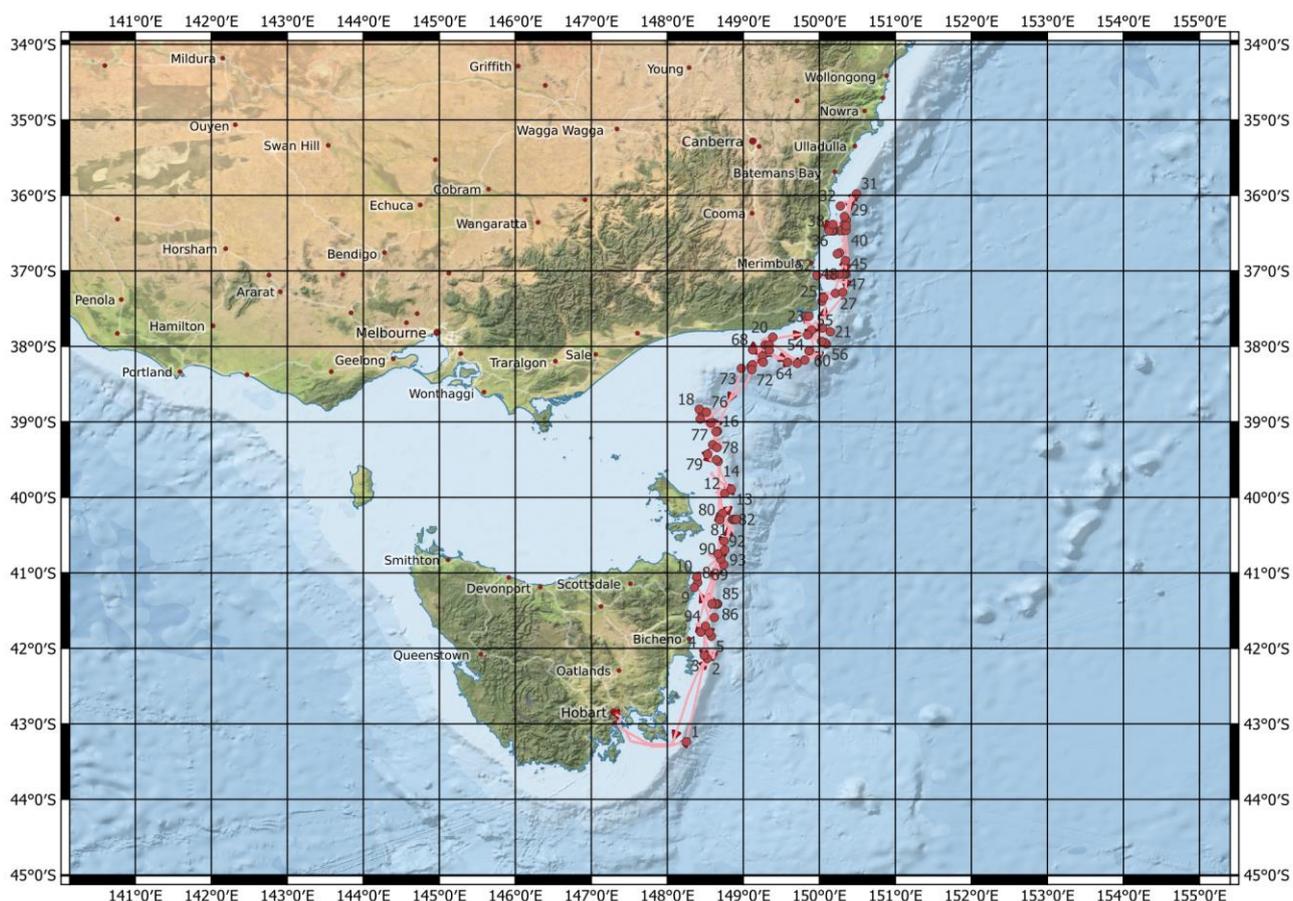


Figure 1: Voyage track with CTD cast locations

2 Data Processing

2.1 Background Information

94 CTD deployments were conducted on this voyage. The data were acquired with the CSIRO CTD unit #24 (Serial Number 1332), a Sea-Bird SBE911 with dual conductivity and temperature sensors.

The CTD was additionally fitted with SBE43 dissolved oxygen sensors, PAR, Fluorometer, transmissometer, CDOM and turbidity sensors. LADCP, Nitrate, sound velocity and temperature depth sensors were added as opportunistic additional payloads. These sensors are described in Table 1.

Sensor Description	Model	Serial No.	A/D Channel	Calibration Date	Calibration Source
Pressure	Digiquartz 410K-134	1332	P	9-Feb-2024	CSIRO
Primary Temperature	Sea-Bird SBE3 <i>plus</i>	6285	T0	27-Aug-2024	Sea-Bird Scientific
Secondary Temperature	Sea-Bird SBE3 <i>plus</i>	6302	T1	27-Aug-2024	Sea-Bird Scientific
Primary Conductivity	Sea-Bird SBE4C	4664	C0	20-Aug-2024	CSIRO
Secondary Conductivity	Sea-Bird SBE4C	4683	C1	20-Aug-2024	CSIRO
Primary Dissolved Oxygen	SBE43	4187	A0	2-Mar-2024	Sea-Bird Scientific
Secondary Dissolved Oxygen	SBE43	4188	A1	5-Mar-2024	Sea-Bird Scientific
Altimeter	Tritech PA500	228403	A2	26-May-2022	Tritech
PAR	Biospherical QCP2300HP	70562	A3	22-Aug-2024	Biospherical
Fluorometer Wetlabs CDOM	FLCDRTD	7138	A4	1-Feb-2024	Sea-Bird Scientific
Transmissometer	WetLabs CSTAR	CST-2009DR	A5	20-Mar-2024	Sea-Bird Scientific
Chlorophyll-A	Wetlabs ECO FLBBRTD	6890	A6	1-Feb-2024	Sea-Bird Scientific
Scattering (Turbidity)	Wetlabs ECO FLBBRTD	6890	A7	1-Feb-2024	Sea-Bird Scientific
Additional Payloads					
LADCP Slave (Up)	Teledyne 300 kHz		Internal	N/A	
LADCP Master (Down)	Teledyne 150 kHz		Internal	N/A	
LADCP Battery	OceanDeep		N/A	N/A	
Nitrate Sensor	SBE Suna	NTR-1890	Serial	23-Oct-2024	Sea-Bird Scientific
Temperature Depth	MOANA TD	947	Internal	N/A	
Temperature Depth	MOANA TD	948	Internal	N/A	
Sound Velocity	SVX	73429	Internal	N/A	

Table 1: CTD Sensor configuration on IN2024_V05

Water samples were collected using a Sea-Bird SBE32, 12-litre 36-bottle rosette sampler.

The raw CTD data were collected in SBE Seasave version 7.26.7.110, converted to scientific units using SBE Data Processing version 7.26.7.129 and written to NetCDF files with CNV_to_Scan (cnv_to_scan_ui2.py, from the CSIRO MNF Data Acquisition and Processing “marinetech” git repository) for processing using the MATLAB-based CapPro software.

The CapPro software version 2.13 was used to apply automated QC and preliminary processing to the data. This included spike removal, identification of water entry and exit times, conductivity sensor lag corrections, conductivity cell thermal inertia corrections, and the determination of the

pressure offsets. It also loaded the hydrology data and computed the matching CTD sample burst data (i.e., averaged sensor data) for water-sample-to-sensor data comparisons. The automatically-determined pressure offsets and in-water points were inspected and verified during data processing.

The bottle sample data were used to compute final conductivity and dissolved oxygen calibrations. These were applied to the data, after which files of binned 1-decibar averaged data were produced.

2.2 Pressure and Temperature Calibration

The pressure offsets for each deployment are plotted in Figure 2. The blue circles refer to initial out-of-water values (beginning of downcast) and the red circles the final out-of-water values (end of upcast).

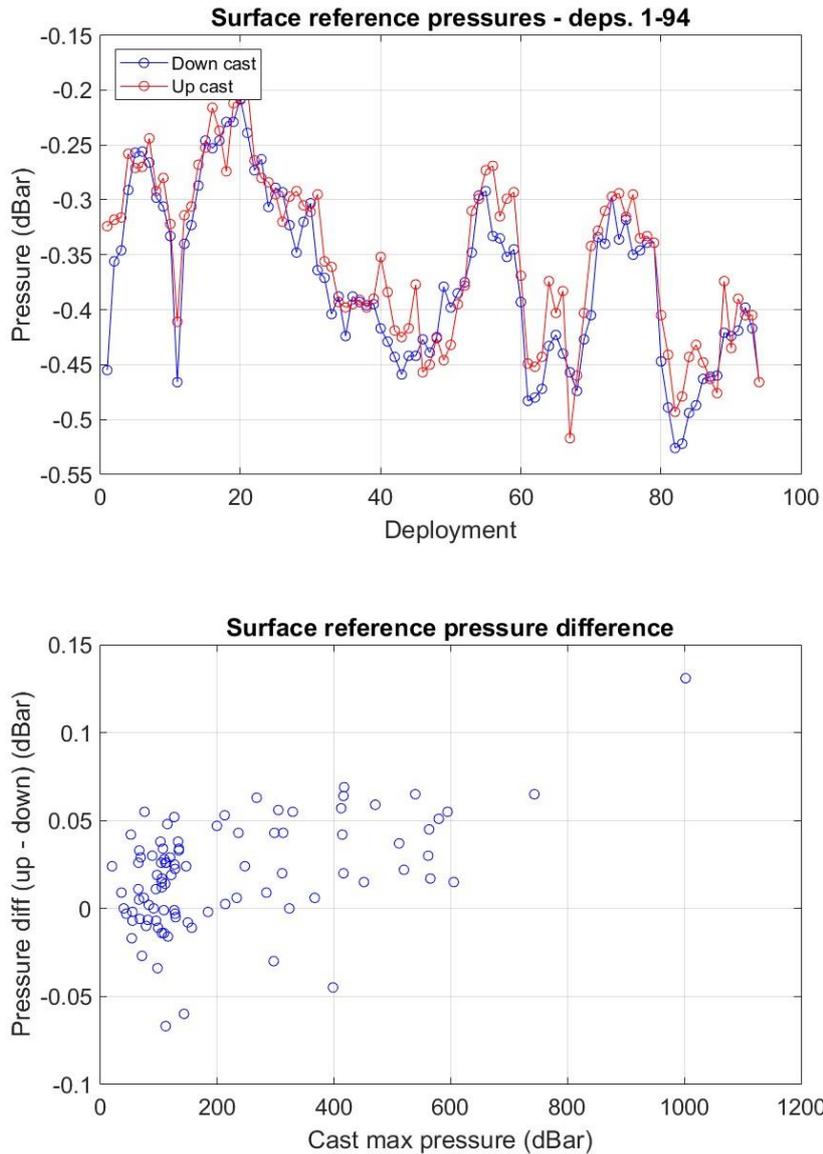


Figure 2: CTD pressure offsets

The difference between the primary and secondary temperature sensors at the bottle sampling depths is plotted in Figure 3. Most deployments plot within ± 0.001 °C of zero – outliers result from sampling in regions of high vertical temperature gradient. The consistent mean difference (red + markers) between the primary and secondary temperature from deployment to deployment indicates neither sensor has drifted significantly from its calibration.

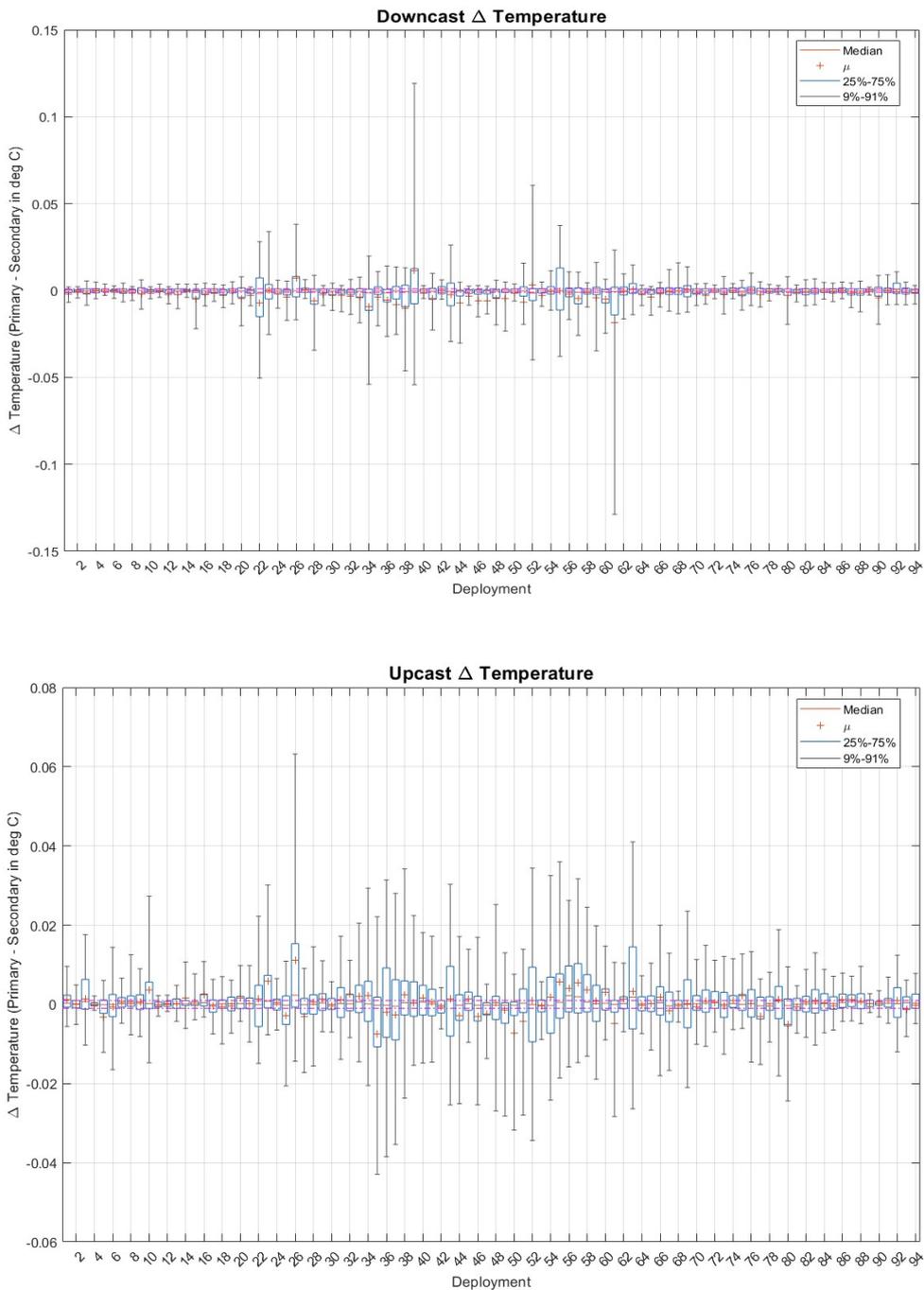


Figure 3: Difference (primary - secondary) between temperature sensor values on downcast (top) and upcast (bottom)

2.3 Conductivity Calibration

If any discrepancies or sampling problems occurred during bottle salinity sampling or between primary and secondary CTD conductivity measurements, these would show in the conductivity calibration plots in Figure 4. We did not observe any sampling problems based on these calibration results. The profile plots showing the thermocline and halocline ranges are in Figure 5.

The calibrations were based upon the percent of 'good' sample data, 212 good samples from the primary unit (74%) and 216 good samples from the secondary unit (75%), out of a total of 287

samples taken during deployments. To perform the calibration with the preferred (default) CapPro calibration settings, a minimum of 70% of the samples need to be in the 'good' range. If there is an insufficient number of good samples for a unit, the conductivity difference 'cutoff' value must be increased to continue with the calibration process in CapPro. For this set of conductivity calibrations, the cutoff values used were 0.003 (primary) and 0.003 (secondary).

Figure 4 plots CTD - bottle salinity differences for both upcast (Hydro bottle) and downcast (CTD SBE43) data. The 'bad' outliers (magenta dots, red dots and red + markers) are excluded from the calibration, the 'suspect' outliers (blue dots) are used in the calibration but are weighted based on their distance from the mean. All green dots are considered 'good' data points and are not weighted based on distance from the mean.

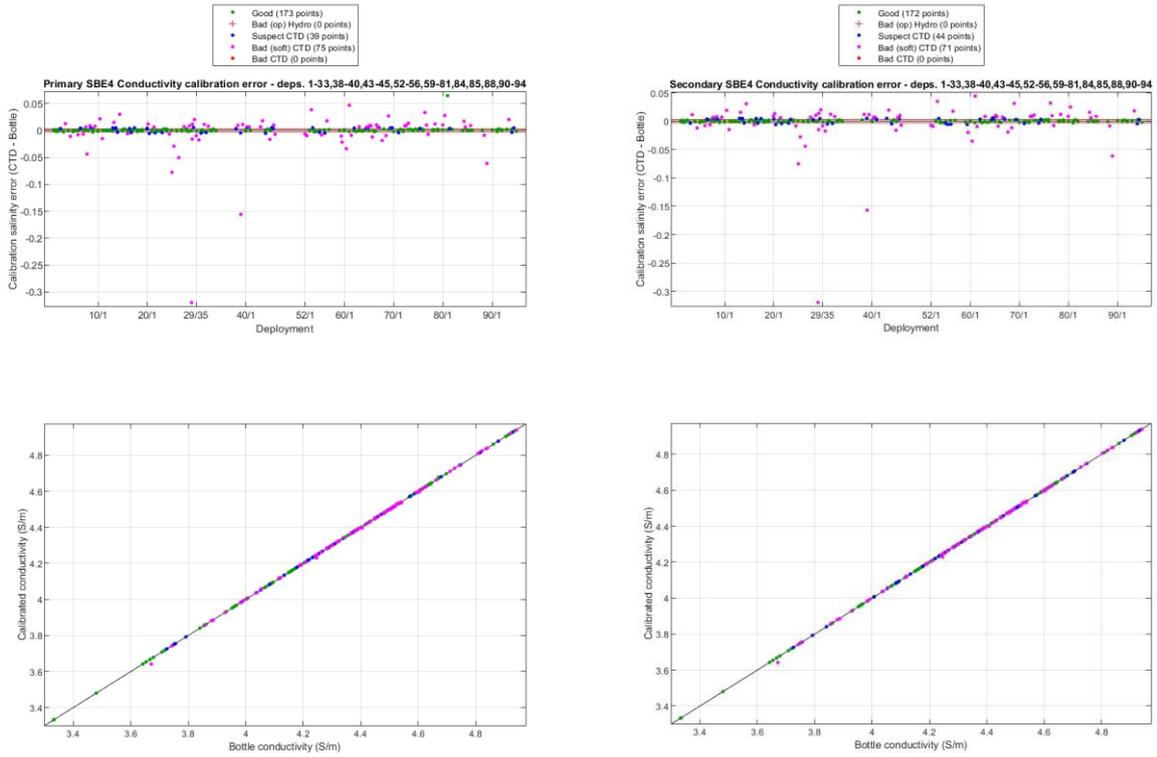


Figure 4: CTD - bottle conductivity difference and salinity calibration error (left: primary, right: secondary)

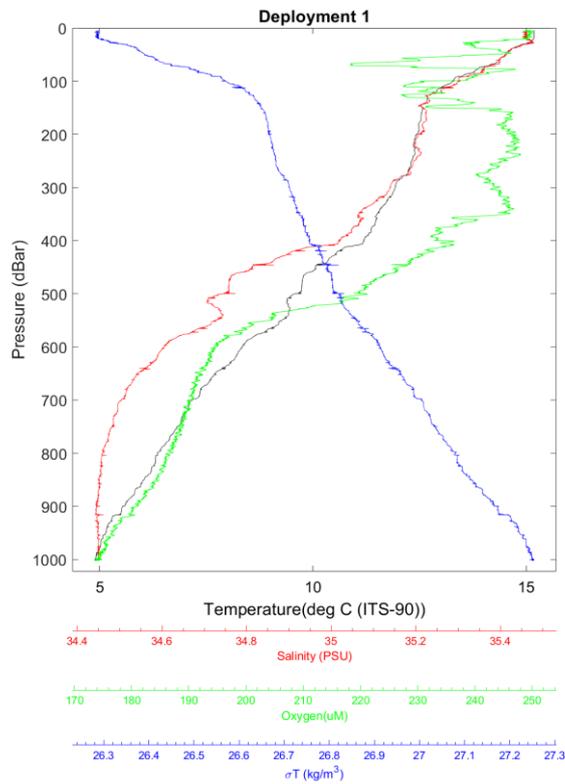


Figure 5: Temperature, salinity, dissolved oxygen and σ_T profiles

The box plot (Figure 6) of calibrated downcast conductivities (primary - secondary) at the bottle sampling depths for all deployments shows that the calibrated primary and secondary conductivity cell responses corresponded very well to each other.

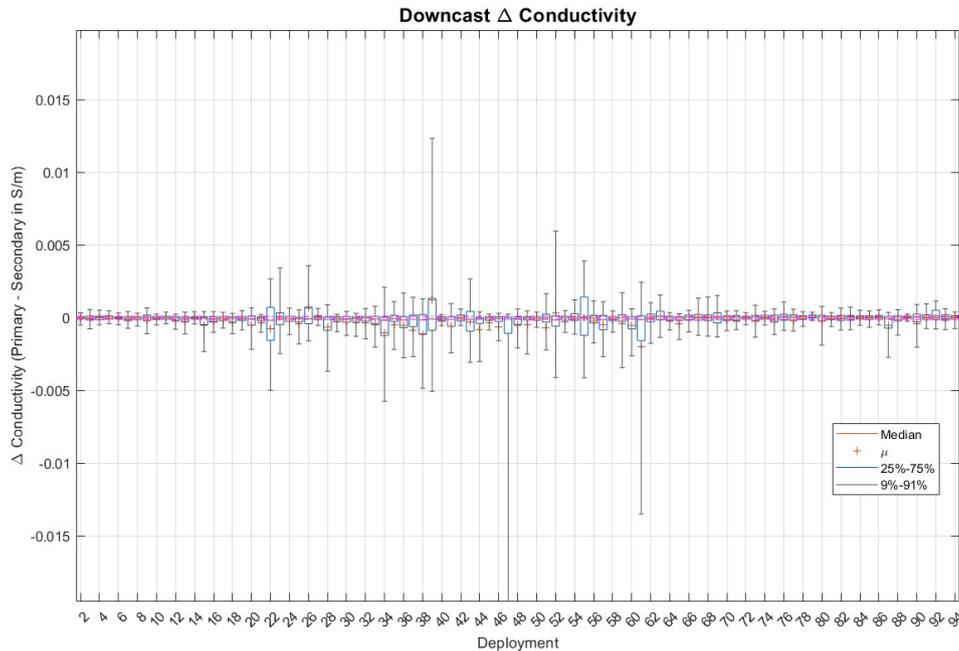


Figure 6: Difference (primary - secondary) between conductivity sensor values on downcast

The final results for the primary and secondary conductivity sensors with respect to their original calibrations are shown in Table 2 and Table 3.

Sensor Group	Deployments	Scale Factor		Offset		Salinity (PSU)	
		a1	±	a0	±	Residual SD	M.A.D.
Primary	1-94	0.99999	0.0015889	-0.00015135	0.0071574	0.0015089	0.0012252
Secondary	1-94	1.0001	0.0015709	-0.00085624	0.0070831	0.0015493	0.0011584

Table 2: Conductivity calibration with respect to manufacturer’s calibration coefficients and post-calibration results

Conductivity Sensor	Deployments	CPcor	±
Primary	1-94	-1.6685e-07	6.1181e-07
Secondary	1-94	-2.1379e-07	6.0719e-07

Table 3: Calculated CPcor (the correction for pressure effects on the conductivity cell) for primary and secondary conductivity units compared to the manufacturer’s nominal value of -9.5700e-08 (for pressure in decibars) (Sea-Bird, 2017)

This is a good calibration. We normally aim for a SD of 0.002 PSU for ‘typical’ oceanographic voyages. The above calibration factors were applied to the indicated deployments. Full plots of residuals before and after calibration are available in A.1.

Data from the primary conductivity and temperature sensors were used to produce the averaged salinities (these data variables have no suffix) with secondary sensors included with a suffix ‘_2’.

2.4 Dissolved Oxygen Sensor Calibration

2.4.1 SBE Calibration Procedure

(Sea-Bird, 2013) describes the SBE43 dissolved oxygen sensor as “a polarographic membrane oxygen sensor having a single output signal of 0 to +5 volts, which is proportional to the temperature-compensated current flow occurring when oxygen is reacted inside the membrane. A Sea-Bird CTD that is equipped with an SBE43 oxygen sensor records this voltage for later conversion to oxygen concentration, using a modified version of the algorithm by Owens and Millard (1985).”

Calibration involves performing a linear regression, as per (Sea-Bird, 2012) to produce new estimates of the calibration coefficients Soc and $Voffset$. These new coefficients are used, along with the other, manufacturer-supplied coefficients, to derive oxygen concentrations from the sensor voltages.

2.4.2 Results

Deeper casts (>1000m) are known to be affected by pressure-induced hysteresis with this sensor. This is corrected automatically within CapPro using the method discussed in (Sea-Bird, 2014).

There is a small mismatch between downcast and upcast dissolved oxygen due to the response time of the sensor. No correction for the sensor lag effect has been applied.

A single calibration group was used with the associated SBE43 upcast data to compute the new Soc and $Voffset$ coefficients. Figure 7 plots CTD SBE43 - bottle oxygen differences for both upcast (Hydro bottle) and downcast (CTD SBE43) data. The ‘bad’ outliers (magenta dots, red dots and red + markers) are excluded from the calibration, the ‘suspect’ outliers (blue dots) are used in the calibration but are weighted based on their distance from the mean. All green dots are considered ‘good’ data points and are not weighted based on distance from the mean.

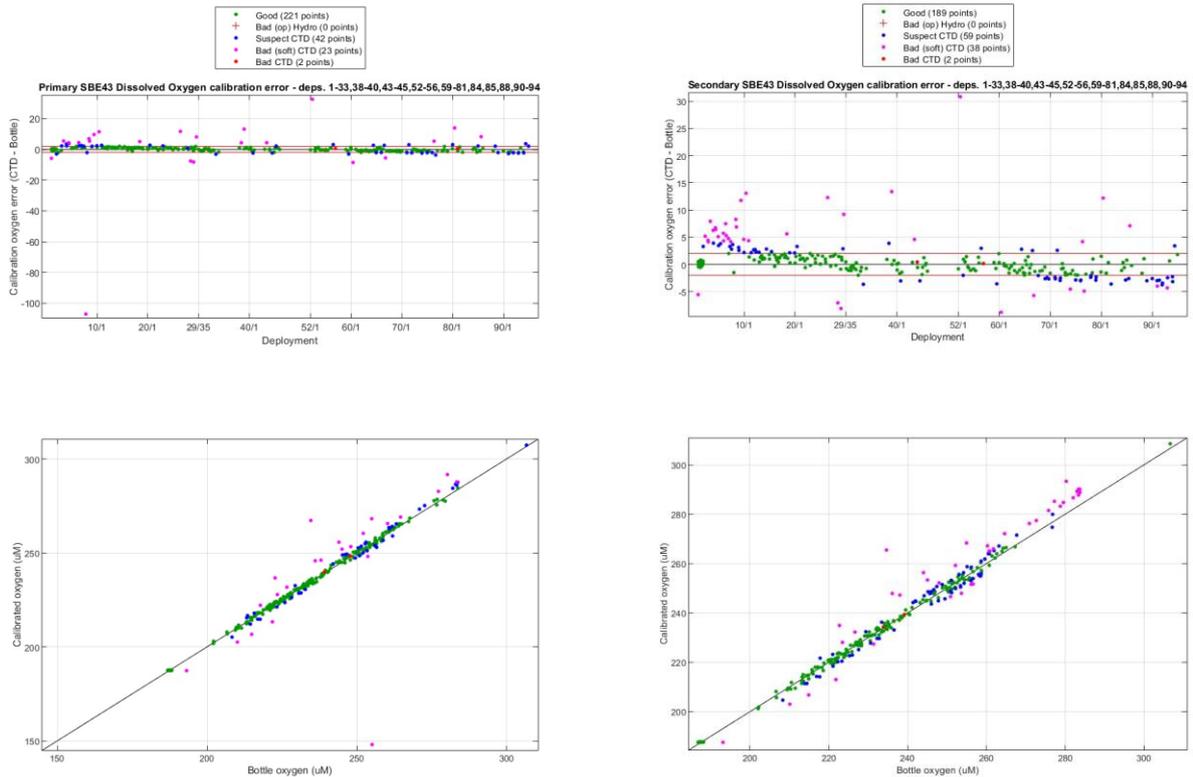


Figure 7: CTD SBE43 - bottle dissolved oxygen difference and calibration error (left: primary, right: secondary)

The box plot (Figure 8) of calibrated downcast dissolved oxygen readings (primary - secondary) at the bottle sampling depths for all deployments shows that the calibrated primary and secondary dissolved oxygen sensor responses corresponded reasonably well to each other.

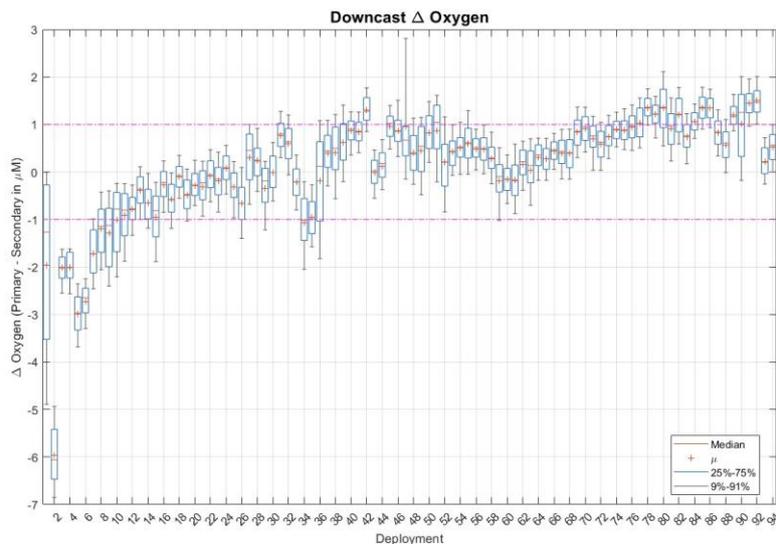


Figure 8: Difference (primary - secondary) between dissolved oxygen sensor values on downcast

The old and new *Soc* and *Voffset* values for DO sensors are listed in Table 4. The *Soc* value is a linear slope scaling coefficient; *Voffset* is the fixed sensor voltage at zero oxygen. As expected, over

time, the increasing *Soc* scale factors show the SBE43 sensor is losing sensitivity. Full plots of residuals before and after calibration are available in A.2.

The calibrations were applied for each sensor and the averaged files were created using the result from the primary sensor.

Sensor	Calibration Source	Deployments	Calibration Coefficients				Dissolved Oxygen (μM)	
			<i>Voffset</i>	\pm	<i>Soc</i>	\pm	Residual SD	M.A.D.
Primary DO	CapPro	1-94	-0.48169	0.0033669	0.59309	0.0013645	0.83742	0.85215
	Sea-Bird	1-94	-0.4970		0.5599			
Secondary DO	CapPro	1-94	-0.52158	0.0044221	0.59026	0.0018087	1.012	1.1247
	Sea-Bird	1-94	-0.5142		0.5419			

Table 4: Dissolved oxygen calibrations

2.5 Other Sensors

2.5.1 C-Star Transmissometer

The C-Star transmissometer was used on all deployments. It was calibrated by the manufacturer with meter outputs with the beam blocked, in air with a clear beam path and with clean water in the path. These values are used to determine a scale and offset for use in SBE Data Processing software to convert the raw counts to a beam transmittance output of 0 - 100 percent.

This sensor worked as expected during this voyage. CapPro determined there was no valid data for Cast 1.

2.5.2 WET Labs ECO CDOM Sensor

The WET Labs ECO CDOM (coloured dissolved organic matter) sensor was used for all deployments. The CDOM has been calibrated with manufacturer supplied coefficients.

This sensor worked as expected during this voyage.

2.5.3 WET Labs ECO Fluorometer-Scattering Sensor

The WET Labs ECO Fluorometer-Scattering sensor was used for all deployments. The fluorometer (Chlorophyll-*a*) has been calibrated with manufacturer supplied coefficients to give outputs in mg/m^3 ($= \mu\text{g}/\text{L}$). The scattering (optical backscatter, OBS) has been calibrated with manufacturer supplied coefficients to give volume scattering outputs in $\text{m}^{-1}\text{sr}^{-1}$.

This sensor worked as expected during this voyage.

2.5.4 Biospherical PAR Sensor

The Biospherical PAR (photosynthetically active radiation) sensor was used for all deployments. The output is a nominal 0 - 5 volts which is converted to the unit $\mu\text{Einsteins}/\text{m}^2/\text{second}$ using a manufacturer supplied wet calibration factor and the dark voltage determined at calibration. This data channel has been included in the output files for all deployments. Time of day and environmental factors such as sea state and cloud cover impact these readings. If most or all of the values for a deployment are near zero it indicates a night-time cast. In deployments where the PAR profiles have sub-surface maxima the CTD may have been shaded by the ship.

This sensor worked as expected during this voyage.

2.5.5 Sea-Bird Scientific Deep SUNA V2 nitrate sensor

The Sea-Bird Scientific Deep SUNA V2 nitrate sensor was mounted on the CTD carousel base for all deployments.

This sensor worked as expected during this voyage.

2.6 Bad-Data Detection

The value limits for each sensor are configured in CNV_to_Scan conversion software and are written to the NetCDF scan file. Typical limits used for the sensor range and maximum second difference are in Table 5. The rejection rate is recorded in the CapPro processing log file.

Sensor	Range minimum	Range maximum	Maximum Second Difference
Pressure	-7	6500	0.5
Temperature	-10	40	0.05
Conductivity	-0.01	7	0.01
Dissolved Oxygen	-0.1	500	0.5
PAR	-5	5000	0.5
Transmissometer	0	100	0.5
Fluorometer Chlorophyll-A	0	30	0.5
Scattering (Turbidity)	0	0.008	0.5

Table 5: Sensor limits for bad-data detection

2.7 Heave Filtering

Sensor data impacted by ship heave impeding the CTD deployment is filtered out in three stages and applied during data binning. The first stage detects negative acceleration of the CTD which can cause trailing mixed water to be pumped through the sensors. The second stage looks at all negative density gradients and flags readings which are above 10 times the standard deviation of

all negative gradients, for 2 seconds. The third stage flags any pressure reversals which are greater than the height of the CTD sensor pump inlet above the frame.

2.8 Temperature-Conductivity Lag

To precisely align the temperature and conductivity measurements for a sample of water a temporal offset can be applied. A manufacturer-recommended nominal offset (Δt_{c_SBE9+}) of -0.073 seconds is initially applied at time of acquisition by the SBE9+ deck unit on both primary and secondary conductivity channels. This offset advances the conductivity sensor readings in time to compensate for the amount of time it takes for the measured water sample to move from the temperature sensor through into the conductivity sensor cell.

Post-voyage inspection of the temperature and conductivity data in CapPro can determine fine-tuning adjustments to the conductivity sample time (seconds) offset (Δt_{c_CP}) that will optimally align the data. The final adjustments applied to the conductivity sample time can be found in Table 6 and Table 7. Note that although CapPro can set an offset ('lag', in number of scans, with a scan frequency of 24 Hz) for both temperature and conductivity samples, DAP only sets a lag for the conductivity sample to maintain consistency with the nominal offset applied by the SBE9+ to the conductivity data. The equation governing this conductivity sample time adjustment is given below, where $t_{c_aligned}$ is the best-estimate of the conductivity measurement time (seconds) to align it with the temperature measurement from the same sample of water on the downcast, and t_{c_meas} is the original, uncorrected conductivity measurement time (seconds).

$$t_{c_aligned} = t_{c_meas} + \Delta t_{c_SBE9+} + \Delta t_{c_CP}$$

Cast #	Nominal Offset Time Applied by SBE9+, Δt_{c_SBE9+} (sec)	Offset ('Cond lag') Set in CapPro (scans)	Calculated Offset Time from CapPro 'Cond lag', Δt_{c_CP} (sec = scans/24 Hz)
01-94	-0.073	0.7	0.0291667

Table 6: Primary conductivity sensor offset adjustments

Cast #	Nominal Offset Time Applied by SBE9+, Δt_{c_SBE9+} (sec)	Offset ('Cond lag') Set in CapPro (scans)	Calculated Offset Time from CapPro 'Cond lag', Δt_{c_CP} (sec = scans/24 Hz)
01-94	-0.073	0.5	0.0208333

Table 7: Secondary conductivity sensor offset adjustments

2.9 Averaging

The calibrated data were 'filtered' to remove pressure reversals and binned into the standard product of 1-decibar averaged NetCDF files. The binned values were calculated by applying a linear, least-squares fit as a function of pressure to the sensor data for each bin, using this to interpolate the value for the bin mid-point. This method is used to avoid possible biases which would result from averaging with respect to time.

Each binned parameter is assigned a quality control (QC) flag (also in the NetCDF files). Our QC flagging scheme is described in (Pender & NCMI Information & Data Centre, 2022).

The QC Flag for each bin is estimated from the values for the bin components. The QC Flag for derived quantities, such as salinity and dissolved oxygen, is taken to be the worst of the estimates for the parameters from which they are derived.

3 References

Little, R. (2024). *The RV Investigator. Voyage Plan IN2024_V05*. Retrieved from Marine National Facility: Voyage Plans and summaries:

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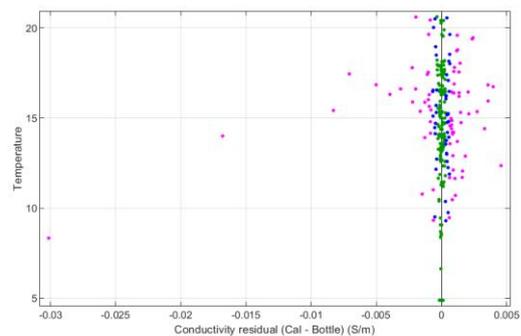
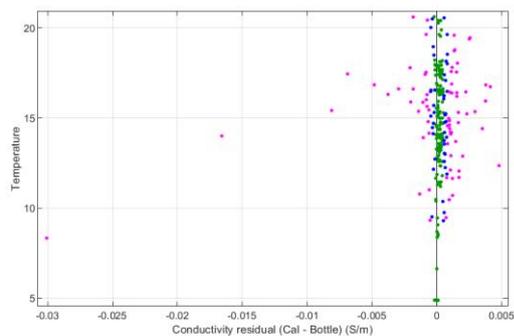
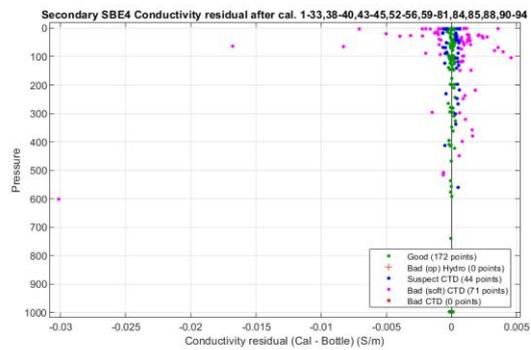
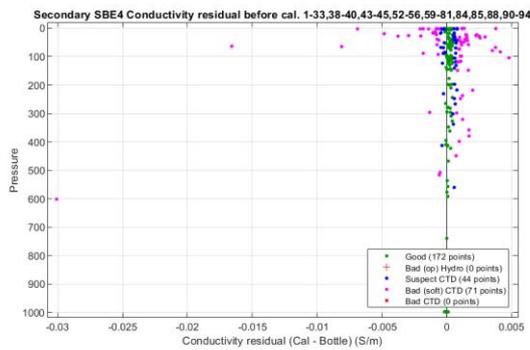
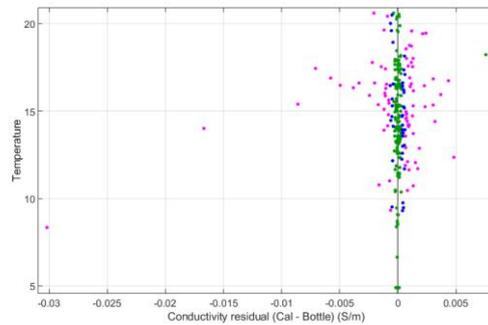
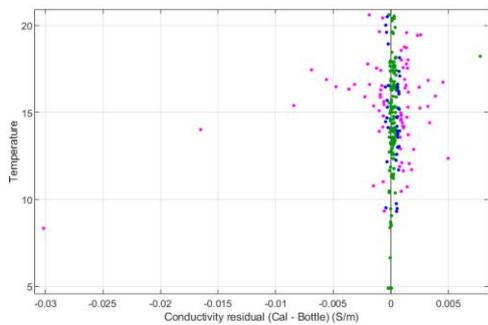
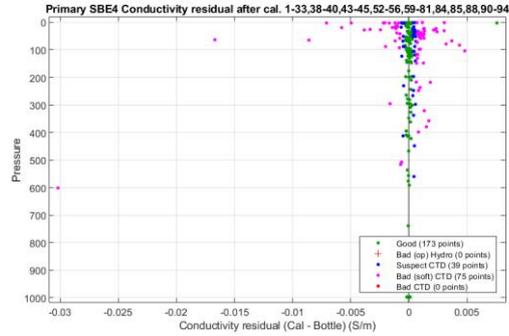
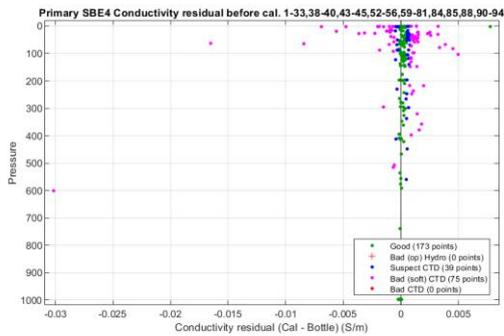
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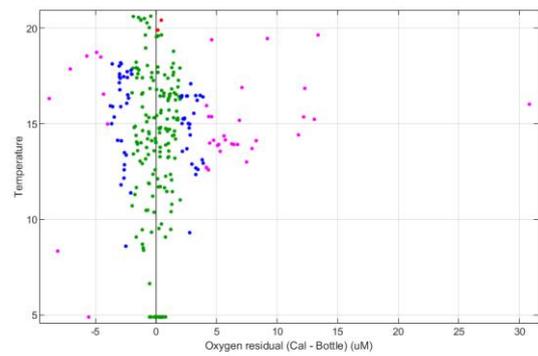
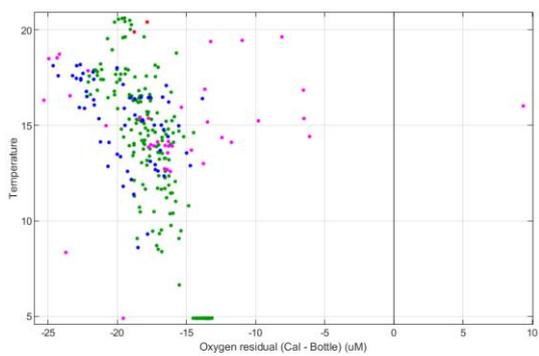
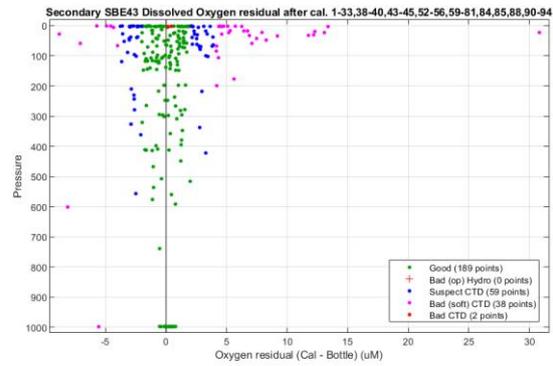
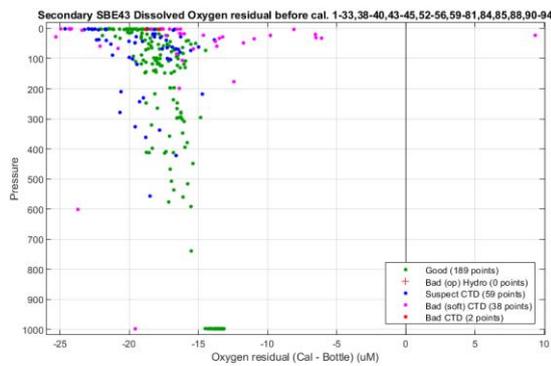
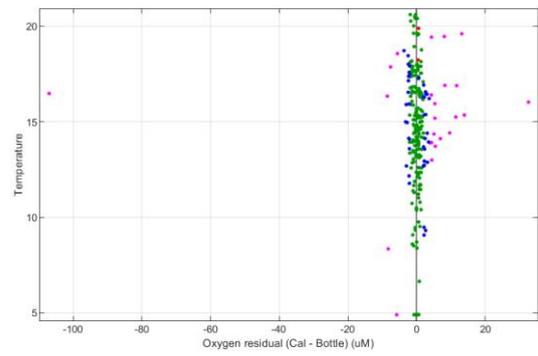
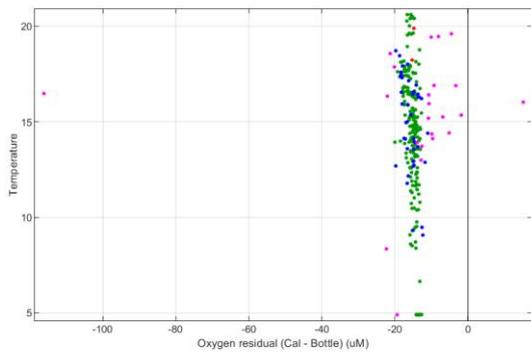
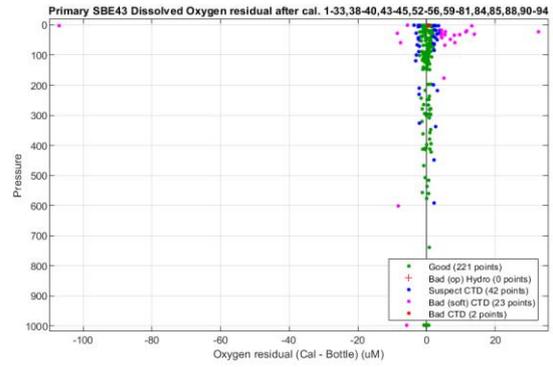
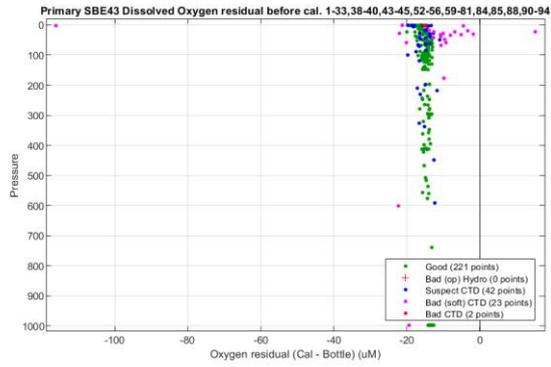
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4 Appendices

A.1 Conductivity Calibration Residual Plots



A.2 Dissolved Oxygen Calibration Residual Plots



A.3 CTD Deployment Summary

Filename	Cast_Start Date	Cast_End Date	H rs	Start Lat	Start Lon	Station Drift_m	Temp_ SN	Cond_S N	Oxyg_ SN	Max_ Depth	Cal_Sa mples	Comments
in2024_v050 01Ctd.nc	13/11/202 4 6:16	13/11/20 24 7:24	1 1	43.2 381	148.25 148	343.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	1002. 4	36	Standard CTD Cast
in2024_v050 02Ctd.nc	13/11/202 4 18:30	13/11/20 24 19:03	0. 6	42.1 381	148.52 7847	159.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	103.5	3	Standard CTD Cast
in2024_v050 03Ctd.nc	13/11/202 4 23:27	13/11/20 24 23:49	0. 4	42.0 969	148.48 8953	13.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	89.3	3	Standard CTD Cast
in2024_v050 04Ctd.nc	14/11/202 4 11:44	14/11/20 24 12:09	0. 4	41.7 864	148.44 0826	20.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	67.2	3	Standard CTD Cast
in2024_v050 05Ctd.nc	14/11/202 4 17:55	14/11/20 24 18:19	0. 4	41.8 414	148.58 0704	30.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	105.7	3	Standard CTD Cast
in2024_v050 06Ctd.nc	14/11/202 4 22:05	14/11/20 24 22:37	0. 5	41.7 897	148.55 1041	31.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	109.4	4	Standard CTD Cast
in2024_v050 07Ctd.nc	15/11/202 4 7:40	15/11/20 24 8:31	0. 8	41.5 933	148.61 969	63.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	520.2	5	Standard CTD Cast
in2024_v050 08Ctd.nc	15/11/202 4 18:19	15/11/20 24 18:47	0. 5	41.1 328	148.40 0635	180.5	[6285, 6302]	[4664, 4683]	[4187, 4188]	74.8	4	Standard CTD Cast
in2024_v050 09Ctd.nc	15/11/202 4 22:10	15/11/20 24 22:43	0. 6	41.1 978	148.35 3912	287	[6285, 6302]	[4664, 4683]	[4187, 4188]	65.7	3	Standard CTD Cast
in2024_v050 10Ctd.nc	16/11/202 4 6:51	16/11/20 24 7:15	0. 4	41.0 503	148.39 0442	49.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	65.6	3	Standard CTD Cast
in2024_v050 11Ctd.nc	17/11/202 4 7:27	17/11/20 24 8:04	0. 6	40.2 133	148.72 8958	54.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	76.3	3	Standard CTD Cast
in2024_v050 12Ctd.nc	18/11/202 4 5:31	18/11/20 24 5:59	0. 5	39.9 501	148.75 7797	51.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	113.4	4	Standard CTD Cast
in2024_v050 13Ctd.nc	18/11/202 4 9:37	18/11/20 24 10:33	0. 9	39.8 948	148.84 2529	560	[6285, 6302]	[4664, 4683]	[4187, 4188]	565.5	6	Standard CTD Cast
in2024_v050 14Ctd.nc	18/11/202 4 18:35	18/11/20 24 19:01	0. 4	39.5 241	148.67 1341	32.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	97.5	3	Standard CTD Cast
in2024_v050 15Ctd.nc	19/11/202 4 1:57	19/11/20 24 2:21	0. 4	39.5 033	148.64 8392	53.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	81.8	3	Standard CTD Cast
in2024_v050 16Ctd.nc	19/11/202 4 9:09	19/11/20 24 10:00	0. 8	39.1 242	148.66 2231	35.5	[6285, 6302]	[4664, 4683]	[4187, 4188]	511.8	6	Standard CTD Cast
in2024_v050 17Ctd.nc	19/11/202 4 18:25	19/11/20 24 19:01	0. 6	38.8 726	148.45 6528	35.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	284.7	3	Standard CTD Cast
in2024_v050 18Ctd.nc	19/11/202 4 22:40	19/11/20 24 23:30	0. 8	38.8 347	148.42 0868	189	[6285, 6302]	[4664, 4683]	[4187, 4188]	398.7	5	Standard CTD Cast
in2024_v050 19Ctd.nc	20/11/202 4 7:50	20/11/20 24 8:16	0. 4	38.9 64	148.43 4143	44	[6285, 6302]	[4664, 4683]	[4187, 4188]	105.7	2	Standard CTD Cast
in2024_v050 20Ctd.nc	20/11/202 4 21:04	20/11/20 24 21:29	0. 4	37.8 793	149.38 9404	17.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	109	4	Standard CTD Cast
in2024_v050 21Ctd.nc	21/11/202 4 8:51	21/11/20 24 9:25	0. 6	37.8 071	150.14 5279	84.7	[6285, 6302]	[4664, 4683]	[4187, 4188]	313.4	4	Standard CTD Cast
in2024_v050 22Ctd.nc	21/11/202 4 18:43	21/11/20 24 19:04	0. 4	37.6 048	149.81 6818	143.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	36.6	3	Standard CTD Cast

in2024_v050 23Ctd.nc	21/11/202 4 21:12	21/11/20 24 21:35	0. 4	37.6 026	149.86 3449		[6285, 6302]	[4664, 4683]	[4187, 4188]	54.3	3	Standard CTD Cast
in2024_v050 24Ctd.nc	22/11/202 4 5:56	22/11/20 24 6:22	0. 4	37.7 562	150.04 0848	218.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	128.3	3	Standard CTD Cast
in2024_v050 25Ctd.nc	22/11/202 4 18:01	22/11/20 24 18:21	0. 3	37.4 043	150.03 2028	22.9	[6285, 6302]	[4664, 4683]	[4187, 4188]	68	3	Standard CTD Cast
in2024_v050 26Ctd.nc	22/11/202 4 20:48	22/11/20 24 21:06	0. 3	37.3 554	150.05 6976	39.7	[6285, 6302]	[4664, 4683]	[4187, 4188]	71.8	3	Standard CTD Cast
in2024_v050 27Ctd.nc	23/11/202 4 7:34	23/11/20 24 7:59	0. 4	37.2 988	150.21 2997	299	[6285, 6302]	[4664, 4683]	[4187, 4188]	112.2	3	Standard CTD Cast
in2024_v050 28Ctd.nc	23/11/202 4 18:24	23/11/20 24 18:57	0. 6	36.3 798	150.33 3664	1279.9	[6285, 6302]	[4664, 4683]	[4187, 4188]	305.2	4	Standard CTD Cast
in2024_v050 29Ctd.nc	23/11/202 4 21:36	23/11/20 24 22:21	0. 7	36.3 288	150.35 8047	961	[6285, 6302]	[4664, 4683]	[4187, 4188]	605.5	13	Standard CTD Cast
in2024_v050 30Ctd.nc	24/11/202 4 11:31	24/11/20 24 11:59	0. 5	36.2 804	150.33 1314	268.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	150.3	3	Standard CTD Cast
in2024_v050 31Ctd.nc	24/11/202 4 21:54	24/11/20 24 22:32	0. 6	35.9 798	150.49 0387	135.7	[6285, 6302]	[4664, 4683]	[4187, 4188]	417.8	5	Standard CTD Cast
in2024_v050 32Ctd.nc	25/11/202 4 8:08	25/11/20 24 8:34	0. 4	36.1 422	150.27 8366	45.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	105.6	3	Standard CTD Cast
in2024_v050 33Ctd.nc	25/11/202 4 16:09	25/11/20 24 16:45	0. 6	36.4 673	150.31 781	554.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	298.7	3	Standard CTD Cast
in2024_v050 34Ctd.nc	25/11/202 4 17:13	25/11/20 24 17:34	0. 3	36.4 675	150.26 9211	432.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	129.5	0	Standard CTD Cast
in2024_v050 35Ctd.nc	25/11/202 4 18:07	25/11/20 24 18:28	0. 3	36.4 694	150.19 5862	360.9	[6285, 6302]	[4664, 4683]	[4187, 4188]	104.8	0	Standard CTD Cast
in2024_v050 36Ctd.nc	25/11/202 4 18:43	25/11/20 24 19:01	0. 3	36.4 688	150.18 3029	426.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	95.9	0	Standard CTD Cast
in2024_v050 37Ctd.nc	25/11/202 4 19:13	25/11/20 24 19:32	0. 3	36.4 697	150.16 9968	325.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	83.5	0	Standard CTD Cast
in2024_v050 38Ctd.nc	25/11/202 4 19:53	25/11/20 24 20:11	0. 3	36.4 713	150.12 8372	325.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	55.5	3	Standard CTD Cast
in2024_v050 39Ctd.nc	25/11/202 4 22:27	25/11/20 24 22:50	0. 4	36.3 858	150.17 7689	143.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	66.8	3	Standard CTD Cast
in2024_v050 40Ctd.nc	26/11/202 4 7:27	26/11/20 24 8:16	0. 8	36.4 633	150.35 3516	353.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	539.7	5	Standard CTD Cast
in2024_v050 41Ctd.nc	26/11/202 4 9:07	26/11/20 24 10:21	1. 2	36.4 035	150.35 4904	283.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	563.3	0	Standard CTD Cast
in2024_v050 42Ctd.nc	26/11/202 4 18:40	26/11/20 24 18:58	0. 3	36.8 652	150.34 5306	330	[6285, 6302]	[4664, 4683]	[4187, 4188]	20.8	0	Standard CTD Cast
in2024_v050 43Ctd.nc	26/11/202 4 22:12	26/11/20 24 22:39	0. 4	36.7 633	150.26 7944	134.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	135.3	3	Standard CTD Cast
in2024_v050 44Ctd.nc	27/11/202 4 7:21	27/11/20 24 7:49	0. 5	36.7 76	150.23 8541	521.7	[6285, 6302]	[4664, 4683]	[4187, 4188]	127.4	3	Standard CTD Cast
in2024_v050 45Ctd.nc	27/11/202 4 14:26	27/11/20 24 15:20	0. 9	37.0 447	150.35 5942	979.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	743.6	5	Standard CTD Cast
in2024_v050 46Ctd.nc	27/11/202 4 15:49	27/11/20 24 16:15	0. 4	37.0 446	150.33 7051	464.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	297.4	0	Standard CTD Cast

in2024_v050 47Ctd.nc	27/11/202 4 16:33	27/11/20 24 16:49	0. 3	37.0 458	150.32 4036		[6285, 6302]	[4664, 4683]	[4187, 4188]	157.1	0	Standard CTD Cast
in2024_v050 48Ctd.nc	27/11/202 4 17:03	27/11/20 24 17:20	0. 3	37.0 458	150.30 4565	293.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	127.2	0	Standard CTD Cast
in2024_v050 49Ctd.nc	27/11/202 4 17:47	27/11/20 24 18:01	0. 2	37.0 469	150.26 3855	266.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	112.4	0	Standard CTD Cast
in2024_v050 50Ctd.nc	27/11/202 4 18:29	27/11/20 24 18:46	0. 3	37.0 509	150.19 7021	203.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	98.5	0	Standard CTD Cast
in2024_v050 51Ctd.nc	27/11/202 4 19:13	27/11/20 24 19:30	0. 3	37.0 546	150.12 8845	112.5	[6285, 6302]	[4664, 4683]	[4187, 4188]	79	0	Standard CTD Cast
in2024_v050 52Ctd.nc	27/11/202 4 20:31	27/11/20 24 20:46	0. 3	37.0 623	149.97 0932	11.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	45.1	3	Standard CTD Cast
in2024_v050 53Ctd.nc	28/11/202 4 7:20	28/11/20 24 7:49	0. 5	37.2 852	150.31 0333	399.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	133.5	4	Standard CTD Cast
in2024_v050 54Ctd.nc	28/11/202 4 18:16	28/11/20 24 18:41	0. 4	37.8 43	149.85 6186	82.7	[6285, 6302]	[4664, 4683]	[4187, 4188]	128.5	3	Standard CTD Cast
in2024_v050 55Ctd.nc	28/11/202 4 21:42	28/11/20 24 22:11	0. 5	37.7 856	149.89 9734	35.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	121.7	3	Standard CTD Cast
in2024_v050 56Ctd.nc	29/11/202 4 6:35	29/11/20 24 7:24	0. 8	37.9 703	150.09 6146	327.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	417	3	Standard CTD Cast
in2024_v050 57Ctd.nc	29/11/202 4 8:06	29/11/20 24 8:47	0. 7	37.9 495	150.07 1594	222	[6285, 6302]	[4664, 4683]	[4187, 4188]	311.7	0	Standard CTD Cast
in2024_v050 58Ctd.nc	29/11/202 4 9:23	29/11/20 24 9:57	0. 6	37.9 361	150.03 2364	54.5	[6285, 6302]	[4664, 4683]	[4187, 4188]	213.3	0	Standard CTD Cast
in2024_v050 59Ctd.nc	29/11/202 4 11:27	29/11/20 24 12:02	0. 6	37.8 502	149.84 5001	106.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	127	4	Standard CTD Cast
in2024_v050 60Ctd.nc	30/11/202 4 2:55	30/11/20 24 3:24	0. 5	38.0 584	149.87 0758	400.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	147.5	3	Standard CTD Cast
in2024_v050 61Ctd.nc	30/11/202 4 18:40	30/11/20 24 19:02	0. 4	37.9 826	149.28 8101	289	[6285, 6302]	[4664, 4683]	[4187, 4188]	107.9	3	Standard CTD Cast
in2024_v050 62Ctd.nc	30/11/202 4 21:20	30/11/20 24 21:42	0. 4	37.9 81	149.33 7738	167.9	[6285, 6302]	[4664, 4683]	[4187, 4188]	110.2	3	Standard CTD Cast
in2024_v050 63Ctd.nc	1/12/2024 8:29	1/12/202 4 8:53	0. 4	38.0 518	149.34 3018	10	[6285, 6302]	[4664, 4683]	[4187, 4188]	119.9	2	Standard CTD Cast
in2024_v050 64Ctd.nc	1/12/2024 18:52	1/12/202 4 19:33	0. 7	38.2 27	149.71 2875	325.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	471.3	5	Standard CTD Cast
in2024_v050 65Ctd.nc	1/12/2024 21:58	1/12/202 4 22:36	0. 6	38.1 827	149.81 0913	38.7	[6285, 6302]	[4664, 4683]	[4187, 4188]	416.8	5	Standard CTD Cast
in2024_v050 66Ctd.nc	2/12/2024 7:42	2/12/202 4 8:28	0. 8	38.2 117	149.58 3832	213.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	412.8	4	Standard CTD Cast
in2024_v050 67Ctd.nc	2/12/2024 21:32	2/12/202 4 21:53	0. 4	38.1 309	149.25 5356	52.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	143.9	2	Standard CTD Cast
in2024_v050 68Ctd.nc	3/12/2024 4:18	3/12/202 4 4:48	0. 5	38.0 476	149.12 3917	213.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	111.6	3	Standard CTD Cast
in2024_v050 69Ctd.nc	3/12/2024 8:26	3/12/202 4 8:56	0. 5	38.2 118	149.26 4435	99.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	248	3	Standard CTD Cast
in2024_v050 70Ctd.nc	3/12/2024 18:26	3/12/202 4 18:53	0. 5	38.2 671	149.10 0861	50.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	268.1	2	Standard CTD Cast

in2024_v050 71Ctd.nc	3/12/2024 21:27	3/12/202 4 21:54	0. 5	38.2 459	149.11 9247		[6285, 6302]	[4664, 4683]	[4187, 4188]	233.8	3	Standard CTD Cast
in2024_v050 72Ctd.nc	4/12/2024 0:54	4/12/202 4 1:45	0. 8	38.3 099	149.11 2183	174.7	[6285, 6302]	[4664, 4683]	[4187, 4188]	561.7	5	Standard CTD Cast
in2024_v050 73Ctd.nc	4/12/2024 6:58	4/12/202 4 7:33	0. 6	38.2 933	148.97 5235	38.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	324	3	Standard CTD Cast
in2024_v050 74Ctd.nc	4/12/2024 18:23	4/12/202 4 18:58	0. 6	39.1 332	148.64 3616	82.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	414.7	3	Standard CTD Cast
in2024_v050 75Ctd.nc	4/12/2024 21:51	4/12/202 4 22:15	0. 4	39.0 172	148.57 5211	64.9	[6285, 6302]	[4664, 4683]	[4187, 4188]	214.3	3	Standard CTD Cast
in2024_v050 76Ctd.nc	5/12/2024 7:22	5/12/202 4 7:58	0. 6	38.8 735	148.51 741	135.5	[6285, 6302]	[4664, 4683]	[4187, 4188]	329.9	3	Standard CTD Cast
in2024_v050 77Ctd.nc	5/12/2024 18:09	5/12/202 4 18:31	0. 4	39.3 039	148.59 8557	12.9	[6285, 6302]	[4664, 4683]	[4187, 4188]	95.5	2	Standard CTD Cast
in2024_v050 78Ctd.nc	6/12/2024 0:18	6/12/202 4 0:49	0. 5	39.3 418	148.65 6342	99.9	[6285, 6302]	[4664, 4683]	[4187, 4188]	367.5	4	Standard CTD Cast
in2024_v050 79Ctd.nc	6/12/2024 7:22	6/12/202 4 7:40	0. 3	39.4 311	148.53 0991	261.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	40.6	2	Standard CTD Cast
in2024_v050 80Ctd.nc	6/12/2024 18:23	6/12/202 4 18:39	0. 3	40.3 017	148.69 1254	21.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	52.9	3	Standard CTD Cast
in2024_v050 81Ctd.nc	7/12/2024 2:32	7/12/202 4 3:00	0. 5	40.2 939	148.85 495	231.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	115.4	3	Standard CTD Cast
in2024_v050 82Ctd.nc	7/12/2024 3:57	7/12/202 4 4:20	0. 4	40.2 957	148.87 7045	98.5	[6285, 6302]	[4664, 4683]	[4187, 4188]	135.1	0	Standard CTD Cast
in2024_v050 83Ctd.nc	7/12/2024 4:42	7/12/202 4 5:12	0. 5	40.2 949	148.89 1159	204.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	237.1	0	Standard CTD Cast
in2024_v050 84Ctd.nc	7/12/2024 5:39	7/12/202 4 6:27	0. 8	40.2 938	148.91 2003	168.1	[6285, 6302]	[4664, 4683]	[4187, 4188]	579.8	4	Standard CTD Cast
in2024_v050 85Ctd.nc	7/12/2024 21:18	7/12/202 4 21:59	0. 7	41.4 138	148.66 4352	153.2	[6285, 6302]	[4664, 4683]	[4187, 4188]	595	4	Standard CTD Cast
in2024_v050 86Ctd.nc	7/12/2024 22:30	7/12/202 4 23:02	0. 5	41.4 142	148.65 2679	173.4	[6285, 6302]	[4664, 4683]	[4187, 4188]	451.8	0	Standard CTD Cast
in2024_v050 87Ctd.nc	7/12/2024 23:23	7/12/202 4 23:44	0. 3	41.4 145	148.63 2401	47.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	185	0	Standard CTD Cast
in2024_v050 88Ctd.nc	8/12/2024 0:12	8/12/202 4 0:32	0. 3	41.4 149	148.58 7738	15.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	116.4	3	Standard CTD Cast
in2024_v050 89Ctd.nc	8/12/2024 18:57	8/12/202 4 19:52	0. 9	40.8 935	148.74 6918	548.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	200.2	0	Standard CTD Cast
in2024_v050 90Ctd.nc	8/12/2024 22:19	8/12/202 4 22:45	0. 4	40.8 176	148.70 343	223.5	[6285, 6302]	[4664, 4683]	[4187, 4188]	99.4	2	Standard CTD Cast
in2024_v050 91Ctd.nc	9/12/2024 2:30	9/12/202 4 2:54	0. 4	40.7 498	148.66 8076	93.6	[6285, 6302]	[4664, 4683]	[4187, 4188]	69.8	3	Standard CTD Cast
in2024_v050 92Ctd.nc	9/12/2024 18:43	9/12/202 4 19:00	0. 3	40.5 811	148.74 9268	241.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	55.7	2	Standard CTD Cast
in2024_v050 93Ctd.nc	10/12/202 4 4:25	10/12/20 24 4:52	0. 4	40.6 986	148.75 8575	155.3	[6285, 6302]	[4664, 4683]	[4187, 4188]	105.9	3	Standard CTD Cast
in2024_v050 94Ctd.nc	10/12/202 4 22:44	10/12/20 24 23:04	0. 3	41.7 087	148.50 4715	62.8	[6285, 6302]	[4664, 4683]	[4187, 4188]	91.9	3	Standard CTD Cast

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